

# Degree of obesity is not associated with more than one intubation attempt: a large centre experience

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## Abstract

**Background:** The role of obesity as a risk factor for difficult intubation remains controversial. We primarily assessed the association between body mass index (BMI) and difficult tracheal intubation.

**Methods:** We analysed electronic records of more than 67 000 adults having elective non-cardiac surgery requiring tracheal intubation at the Cleveland Clinic between 2011 and 2015. The association between BMI and difficult intubation, defined as more than one intubation attempt, was assessed using multivariable logistic regression adjusting for pre-specified confounders.

**Results:** Amongst 40 183 patients with BMI <30 kg m<sup>-2</sup> and 27 519 with BMI ≥30 kg m<sup>-2</sup>, 9% required more than one intubation attempt. Increasing BMI up to 30 kg m<sup>-2</sup> was significantly associated with increased odds of more than one intubation attempt [odds ratio (OR): 1.03; 97.5% confidence interval (CI): 1.02, 1.04] per unit increase in BMI, *P* < 0.001.

However, the odds of difficult intubation remained unchanged once BMI exceeded 30 kg m<sup>-2</sup> (*P* = 0.08). The results were similar when analysis was restricted to patients without history of airway abnormalities in whom intubation was attempted using a standard direct laryngoscope (OR: 1.03; 99.4% CI: 1.01, 1.04) per kg m<sup>-2</sup> increase in BMI <30 kg m<sup>-2</sup>).

**Conclusions:** Increasing BMI was associated with increasing odds of difficult intubation in the lean range. At higher BMI, the odds of difficult intubation remain elevated, but there is no additional increase in odds with further increase in BMI. Obese patients were thus harder to intubate than lean ones, but difficult intubation was no more likely in morbidly obese patients than in those who were only slightly obese.

**Keywords:** airway management; body mass index; laryngoscopy; obesity; morbid

**Editor's key points**

- It is still not clear whether or not tracheal intubation is more difficult in obese patients than in lean patients.
- A single centre retrospective analysis of electronic data was conducted to assess the relationship between intubation difficulty and BMI in patients undergoing non-cardiac surgery.
- Tracheal intubation was more difficult with increasing BMI, but the odds of difficult intubation remained unchanged once BMI exceeded 30 kg m<sup>-2</sup>.

The World Health Organization defines obesity as a BMI exceeding 30 kg m<sup>-2</sup>; by this definition two-thirds of the US population may be obese.<sup>1</sup> Obesity is associated with multiple medical comorbidities such as metabolic syndrome, hypertension, diabetes, and anatomical changes that can result in gastro-oesophageal reflux and obstructive sleep apnoea. Each contributes to the risk of perioperative morbidity and mortality.<sup>2-4</sup> Additional potential consequences of obesity are difficulties during airway management (ventilation, intubation, or both).<sup>5-7</sup>

Airway management, including tracheal intubation, is a cornerstone of perioperative anaesthesia and requires considerable experience and skill. Difficulties encountered during airway management increase the risk of perioperative morbidity and mortality.<sup>5,6,8-10</sup> Obese patients present with varying degrees of fat deposition at key locations of the airway. Consequently, morbidly obese patients are thought to be at increased risk for difficult airway management. For example, difficult intubations have been reported in up to 15% of seriously obese patients<sup>11-13</sup> compared with 2-6%<sup>12-14</sup> in lean patients. Obesity also reduces oxygen reserve, thereby decreasing the time available for airway manipulations.

Whether obesity complicates intubation attempts remains unresolved, with some studies reporting that obesity is a risk factor<sup>9,15,16</sup> and others not.<sup>11,17</sup> However, based on clinical experience and morphologic changes consequent to obesity, we expected body mass to have little effect on intubation difficulty in lean patients, and that intubation would become progressively more difficult with increasing BMI. This is supported by reported difficult intubations in the obese population both in and out of the operating room.<sup>6,7</sup> Our goal was thus to evaluate the relationship between BMI and difficult tracheal intubation. Specifically, we tested the hypothesis that there is an association between BMI and more than one intubation attempt in obese surgical patients.

**Methods**

With approval of the Institutional Review Board of the Cleveland Clinic Foundation (16-474) and waived consent, this retrospective cohort registry analysis included adults who had elective non-cardiac surgery under general or combined anaesthesia with tracheal intubation at the Cleveland Clinic Main Campus between January 2011 and September 2015. Data were obtained from the Cleveland Clinic Perioperative Health Documentation System, an electronic registry including data containing patient demographics and baseline characteristics, the preoperative airway evaluation (including expected difficulty and significant airway abnormalities as judged by an attending anaesthesiologist), unexpected airway difficulties,

and the number of intubation attempts. Patients were excluded if they had missing intubation device data, received fiberoptic or bronchoscopic intubation, received neither or both regular direct or videolaryngoscopy or had incomplete data on intubation attempts, BMI, or potentially confounding characteristics. Only the first intubation attempt was considered for each patient.

The primary relationship of interest was the association between BMI and difficult tracheal intubation, defined as requiring more than one intubation attempt. To assess whether the relationship between BMI and the probability of difficult intubation is linear, we plotted the estimated probability of requiring more than one intubation attempts across the observed range of BMI, using a univariable logistic regression incorporating a smooth (natural cubic spline with knots at 10th, 25th, 50th, 75th, and 90th percentile) term for BMI.<sup>18</sup> As patterns differed below and above a BMI of 30 kg m<sup>-2</sup> and because BMI >30 kg m<sup>-2</sup> is the World Health Organization threshold for obesity, we constructed separate multivariable logistic regression models for BMI values below and above 30 kg m<sup>-2</sup>.<sup>1,19</sup>

Each model was adjusted for the following pre-specified potential confounding variables: age, gender, ASA physical status, Mallampati score, significant airway abnormality, short neck, small mouth opening, short thyromental distance, beard present, rheumatoid arthritis, diabetes mellitus, cervical spine surgery, type of surgery [US agency for healthcare research and quality's clinical classification software (AHRQ-CCS) categories], and year of surgery.

Secondarily, we assessed the associations between BMI and difficult intubation separately for regular and videolaryngoscopy with and without any significant airway abnormality (yes vs no) using the same approach as the primary analysis.

As a *post hoc* sensitivity analysis, we assessed the association between BMI >30 kg m<sup>-2</sup> with the odds of difficult intubation using a multivariable logistic regression model adjusting for the same potentially confounding factors as in the primary analysis.

The significance criterion was adjusted using Bonferroni corrections. Thus,  $P < 0.025$  was considered statistically significant for the two primary analyses, whereas  $P < 0.006$  was required for the eight secondary analyses.

**Sample size considerations**

We planned to use all available patients who met our inclusion criteria (approximately 100 000 patients based on a recent query of the Cleveland Clinic Perioperative Health Documentation System). We have more than 99% power to detect an odds ratio (OR) of 1.05 or more per kg m<sup>-2</sup> increase in BMI at the overall 0.05 significance level, assuming a mean (standard deviation) BMI of 30 (8) kg m<sup>-2</sup> and an 8% incidence of having difficult intubation (based on a recent query of our registry).

SAS software version 9.4 (SAS Institute, Cary, NC, USA) was used for all statistical analyses.

**Results**

Analyses included 67 702 eligible adults who had non-cardiac surgery with general or combined anaesthesia with tracheal intubation at the Cleveland Clinic Main Campus hospital between January 2011 and September 2015 (Fig. 1). Amongst them, 56% were female, and the average age was 56 (16) yr. The

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